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Xavier Aquilué, Miguel Ángel Cau-Ontiveros
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Western Greek amphorae produced in colonial western Sicily: overview of an interdisciplinary research on the series of Himera, *Selinunte, and Agrigento (mid 6th-early 4th centuries BCE)*

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1. *Introduction*

During their earliest settlement phases, Sicilian Greek colonies imported amphorae-born commodities[1] from extra-regional regions, primarily from Athens, Corinth, and the Aegean area[2]. These plausible 'primary-content amphorae'[3] conceived for large-scale and long-distance trade of one major product (wine and olive oil[4]) dominated the markets of the Archaic Sicilian city-states, which were among the most important consumption areas of the central Mediterranean. The intensive manufacture of Sicilian transport containers[5], that is western Greek-type vessels[6], did not begin until the later 6th century BCE in the colonial *milieu* with some forerunners from the mid-6th century BCE onwards (see ch. 2.1)[7].

There is a certain difficulty in distinguishing the Archaic amphorae productions of the western Sicilian Greek colonies based only on stylistic-formal aspects and macroscopic fabric. An 'integrated archaeometric approach' has proven to be an effective tool in this sense. In fact, through the contribution provided by a direct knowledge of the local geo-lithological context, by the in-depth compositional and textural characterisation of the potential clayey raw materials, it was possible to highlight some characteristic 'markers' functional to distinguish the individual productions.

1 This statement does not include transport vessels manufactured in the native *milieu* of Sicily's fertile hinterland. For an in-depth discussion of these classes, see Serra 2016 (flat-based amphorae) and Albanese Procelli 2021 (*pithoi*).
2 Brun 2010: 427; Brun 2011: 107; for a synthesis, see also Klug 2013: 42-46. Most recent, see Pratt 2016. Still valid, even if not up-dated, remain also R. M. Albanese Procellli's (1996; 1997) contributions. Specifically, and by way of example, for Camarina, see Sourisseau 2006; for Messina, see Spagnolo 2002.
3 Lawall 2011: 23-33.
4 The most recent critical discussion can be found in Brun 2011.
5 The possible identification of Archaic colonial 'imitations'/adaptations of Attic SOS and "à la brosse" (Albanese Procelli 1996: 102-103; Pratt 2016) and Corinthian A-type (Albanese Procelli 1996: 95-96; Sourisseau 2011: 188-189) amphorae still has to be corroborated by systematic archaeometric research. For the Phoenician-Sicilian series which date back to the later 8th century BCE (Mozia) and to the end of the 7th centuries BCE (Solunto/Palermo), see Bechtold and Vassallo 2018.
6 The term 'western Greek' denotes 6th-4th centuries BCE transport vessels manufactured by export-orientated Greek colonies of *Magna Graecia* and Sicily, see latest Sourisseau 2011; Sacchetti 2012; Gassner 2015.
7 The most recent and exhaustive discussion on Sicilian western Greek amphorae is in Bechtold and Vassallo 2023: ch. 5.2.4, 5.3.

Inter alia, this paper summarises the most relevant issues of recent interdisciplinary research on amphorae production in the westernmost Sicilian Greek colonies of *Himera*, Selinunte, and Agrigento (Fig. 1). It consists of a comprehensive review of the archaeometric researches issued on this topic by the authors themselves in the last five years (see ch. 2.1-2.3). It aims to concisely re-discuss the published results in a comparative way so as to offer a hands-on resource for verifying the distribution of Sicilian western Greek vessels in the Mediterranean basin.

Fig. 1.- Geographical localisation of the main sites mentioned in this study.

2. *Archaeological materials and analytical methods*

Within the wider frame of multidisciplinary provenance studies on approximately 1200 western Greek amphorae mainly discovered in Sicilian sites[8], ceramic samples chipped from the materials were subdivided into macro-fabrics using hand lenses. In the following, all the samples were analysed according to the standardised methods of FACEM ('Fabrics of the Central Mediterranean') and compared with reference samples of fabrics already defined by former interdisciplinary research. The utilisation of a stereomicroscope and macro-photos in triple magnification (x8, x16, x25) led to the selection of a group of 87 amphorae representative fragments which have been previously attributed to the local series of western Greek amphorae fragments which have been attributed to the local series of western Greek amphorae of *Himera*,

8 Research funded by Austrian Science Fund (FWF) project P 30030-G25. Major results published in Bechtold and Vassallo 2023 and in the eight edition of the database of 'Fabrics of the Central Mediterranean' (FACEM).

Selinunte, and Agrigento based on macroscopic and morphological features. The entire sample selection has then been submitted to a deeper analytical archaeometric analyses in order to confirm the specific site of production and define the corresponding minero-petrographic and chemical markers. It should be underlined that both the *micro-fabrics* of the amphorae (obtained from the observation of thin-sections at the polarizing microscope) and the raw elemental concentrations were successfully correlated with the data obtained (by the same analytical routine used for the archaeological samples) from the experimental firings of the local clay raw materials.

The detailed descriptions of procedures and methods used for minero-petrographic and chemical analysis are fully available in previous papers.

Thin-section petrographic observations were carried out by means of a Leica DC 200 polarizing microscope equipped with a digital camera. The relative abundance of non-plastic inclusions (expressed as area %) was determined by conventional point-counting procedures (Matthew, Woods and Oliver 1991). Bulk chemical data were determined by the Activation Laboratories Ltd (Ontario, Canada), using fusion inductively coupled plasma optical emission spectrometry (ICP-OES) for determining major elements and inductively coupled plasma mass spectrometry (ICP-MS) for trace elements. In this case 3-5 grams of ceramic were first air-dried, crushed and homogenized in a planetary agate ball-mill (Retsch PM100), then were mixed with a flux of lithium metaborate and lithium tetraborate and fused in an induction furnace. The molten specimen was immediately poured into a solution of 5% nitric acid containing an internal standard until completely dissolved. The samples were accordingly run for major oxides and selected trace elements on a combination simultaneous/sequential Thermo Jarrell-Ash ENVIRO II ICP or a Varian Vista 735 ICP. Calibration was performed using 7 prepared USGS- and CANMET-certified reference materials.

2.1. *Western Greek amphorae produced in* Himera[9]

Dorian-Chalcidian *Himera* was founded shortly after the mid-7th century BCE at the northwestern edge of the *Himera* plain, on the mouth of the river *Imera Settentrionale*. The ample agricultural and pastoral hinterland inhabited by native communities favoured rapid urbanistic and economic development, especially during the 6th century BCE. In 409 BCE, *Himera* was destroyed by the Carthaginian army and never systematically re-occupied thereafter.

The in-depth study of 556 western Greek amphorae re-used in *enchytrismos* burials of the city's cemeteries allowed for the complete archaeological and archaeometric characterisation of the local series. The earliest type *Himera* 1 can be classified as form 1α with *Randform* 1[10] (Fig. 2a-b). It is dated, through context and morphological comparisons, to the third quarter of the 6th century BCE. Sub-globular or heart-shaped form 2-vessels distinguish the series of the last two decades of the 6th and the earlier 5th century BCE. Their *Randform* 3-rims occur in two variants: *Himera* 2.1 with massive semi-ovoid rims (Fig. 2c) or *Himera* 2.2 with elongated semi-ovoid rims (Fig. 2d). At present, we do not have any secure evidence for local vessels dating to the second-third quarter of the 5th century BCE. Amphorae production in *Himera* was documented again during the last decade of the colony's life through ovoid containers with concave necks and rims of *Randform* 7 labelled *Himera* 3 (Fig. 2e-f). While the Archaic artifacts show the

9 For reasons of space, we here summarise the most significant data previously published in Bechtold, Vasallo and Ferlito 2019; Bechtold 2020a; Montana, Randazzo and Bechtold 2020; Bechtold and Vassallo 2023: 92-99.

10 In this paper typological classification refers to Sourisseau 2011 ('form') and Gassner 2003 ('*Randform*').

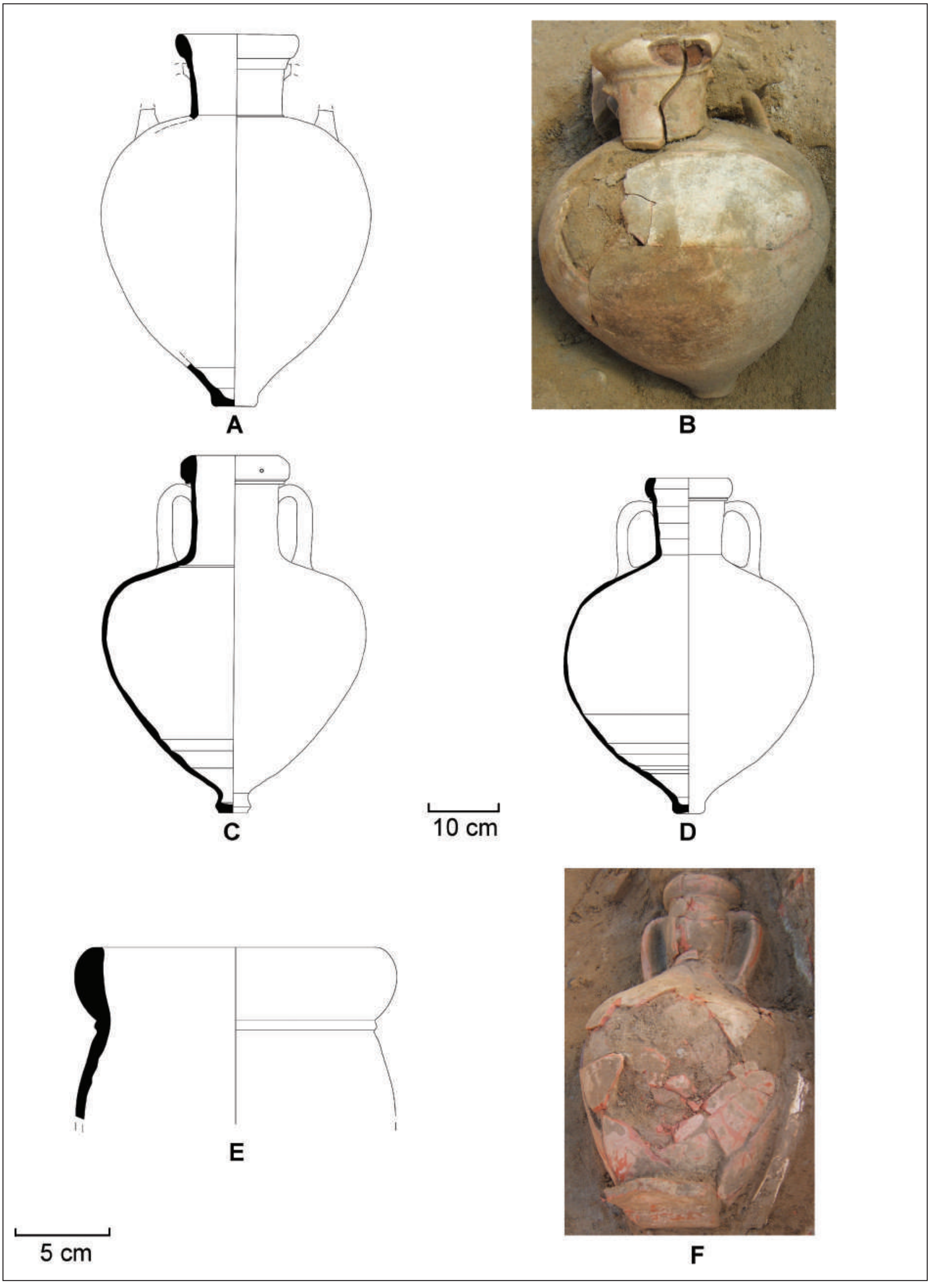

Fig. 2.- Western Greek amphorae of *Himera*. A-B: *Himera* 1; C: *Himera* 2.1; D: *Himera* 2.2; E-F: *Himera* 3.

coarse macro-fabric HIM-A-1 (Fig. 3a), the finer macro-fabric HIM-A-2 (Fig. 3b) is found from the late Archaic period onwards, with the appearance of form 2-amphorae.

To date, *c.* 20 amphorae produced in *Himera* have been identified in several native sites of the colony's *chora*[11]. The most prominent example is the hill-site of Terravecchia di Cuti where form 1α and form 2-vessels are best attested during the second half of the 6th and the earlier 5th century BCE[12].

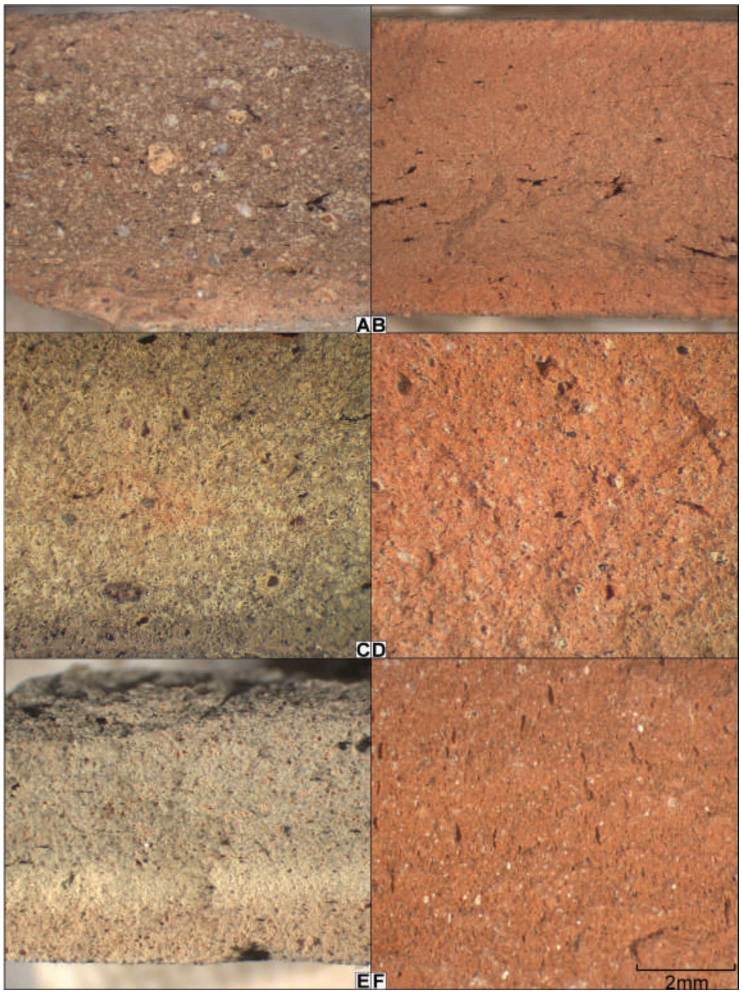

Fig. 3.- Macro-photos of archaeological fabrics at x8 magnification.
A: HIM-A-1; B: HIM-A-2; C-D: SEL-A-4; E-F: AKR-A-1.

2.2. *Western Greek amphorae produced in Selinunte*[13]

The Megarian Hyblean colony of Selinunte was founded in the second half of the 7th century BCE on the mouthes of the rivers *Modione* and *Gorgo Cotone*. Archaic-Classical *Selinus* controlled a wide and fertile hinterland being the probably partly navigable river *Hypsas-Belice*

11 The publication of these materials is currently being prepared by B. Bechtold and A. Burgio.

12 Bechtold and Burgio forthcoming.

13 For reasons of space, we here summarise the most significant data previously published in Bechtold 2020b; 2021; Bechtold and Vassallo 2023: 123; Montana *et alii* forthcoming.

the privileged trade axis towards the native *milieux* of its *chora*. After almost two centuries of overall economic and demographic growth and prosperity, Selinunte was destroyed by the Carthaginians in 409 BCE. After 405 BCE, the city came under Punic control and became a multi-ethnic community. In 250 BCE, the site was captured by the Romans and partially reoccupied only from the late Antiquity onwards.

The chrono-typological characterisation of the local series of western Greek amphorae and the definition of its archaeometric fingerprint is based on recent interdisciplinary research of 40 fragments found in several excavations undertaken in Selinunte.

Currently, the earliest local type is represented by late Archaic *Randform* 3-rims with slightly moulded inferior edge and sub-globular belly (Fig. 4a-b). Some fragments classified as *Randform* 5 (Fig. 4c) and an intermediate shape between *Randform* 2/6 with a slightly convex neck (Fig. 4d) can be dated to the second third of the 5th century BCE. A considerable selection comprises rims underlined by a ridge above convex necks like *Randform* 7. The earliest variant (*c*. 440-420 BCE) exhibits almost vertical lips and straight inner profile (Fig. 4e). This is succeeded, in the last quarter of the century by noticeably thinner rims with concave inner profiles that gently slope outwards (Fig. 4f). The last group is characterised by clearly everted rims with an angle of at least 20° (Fig. 4g) and may well date to the early 4th century BCE. All of the local amphorae are distinguished by a pinkish-orange or reddish-yellow carbonatic matrix of rather fine texture labelled SEL-A-4 (Fig. 3c-d). A part from one vessel found in the western necropolis of *Himera*, no assessment can currently be made on the distribution of the class in the regional context. However, macroscopic archaeological fabric studies suggest the documentation of a few items in the non-Greek settlements of Segesta and Pantelleria[14].

2.3. Western Greek amphorae produced in Agrigento[15]

Situated in the central part of Sicily's southern coast, *Akragas* was founded around 580 BCE by nearby Gela. As a result of the battle of *Himera* in 480 BCE, Agrigento's tyrants extended their supremacy over the Dorian-Chalcidian colony and large parts of northwestern Sicily until *c*. 470 BCE. During the 5th century BCE, the city developed very quickly until it was sieged and conquered by the troops of Hannibal in 406 BCE.

Sub-globular form 2-vessels with rather thick semi-ovoid *Randform* 3-rims (Fig. 5a) represent the earliest type *Agrigento* 1 of the late 6th-early 5th century BCE. A minor selection shows *Randform* 2 without external modulation (Fig. 5b). Heart-shaped amphorae with massive bottom-shaped pegs and thinned *Randform* 3-rims (Fig. 5c-d), labelled *Agrigento* 2, probably represent the early Classical-period evolution. Currently, local amphorae dating to the span of time between the Emmenidian tyranny (490/89-471 BCE) and the last third of the 5th century BCE are almost absent in our archaeological record. Better attested is the late Classical series documented by semi-ovoid rims with their barycenter in the upper third and underlined by a ridge, closely resembling *Randform* 7 (Fig. 5e-f). All of the local amphorae have been attributed to the rather fine-grained macro-fabric AKR-A-1 (Fig. 3e-f).

Notably, and in contrast to the above series of *Himera* and Selinunte, *Akraga*s presently stands out as the only candidate for a modest distribution of its amphorae-packed commodities

14 Bechtold 2020b: 6, fig. 2.

15 For reasons of space, we here summarise the most significant data previously published in Bechtold 2020c; 2022; Montana *et alii* 2022; Bechtold and Vassallo 2023: 99-104.

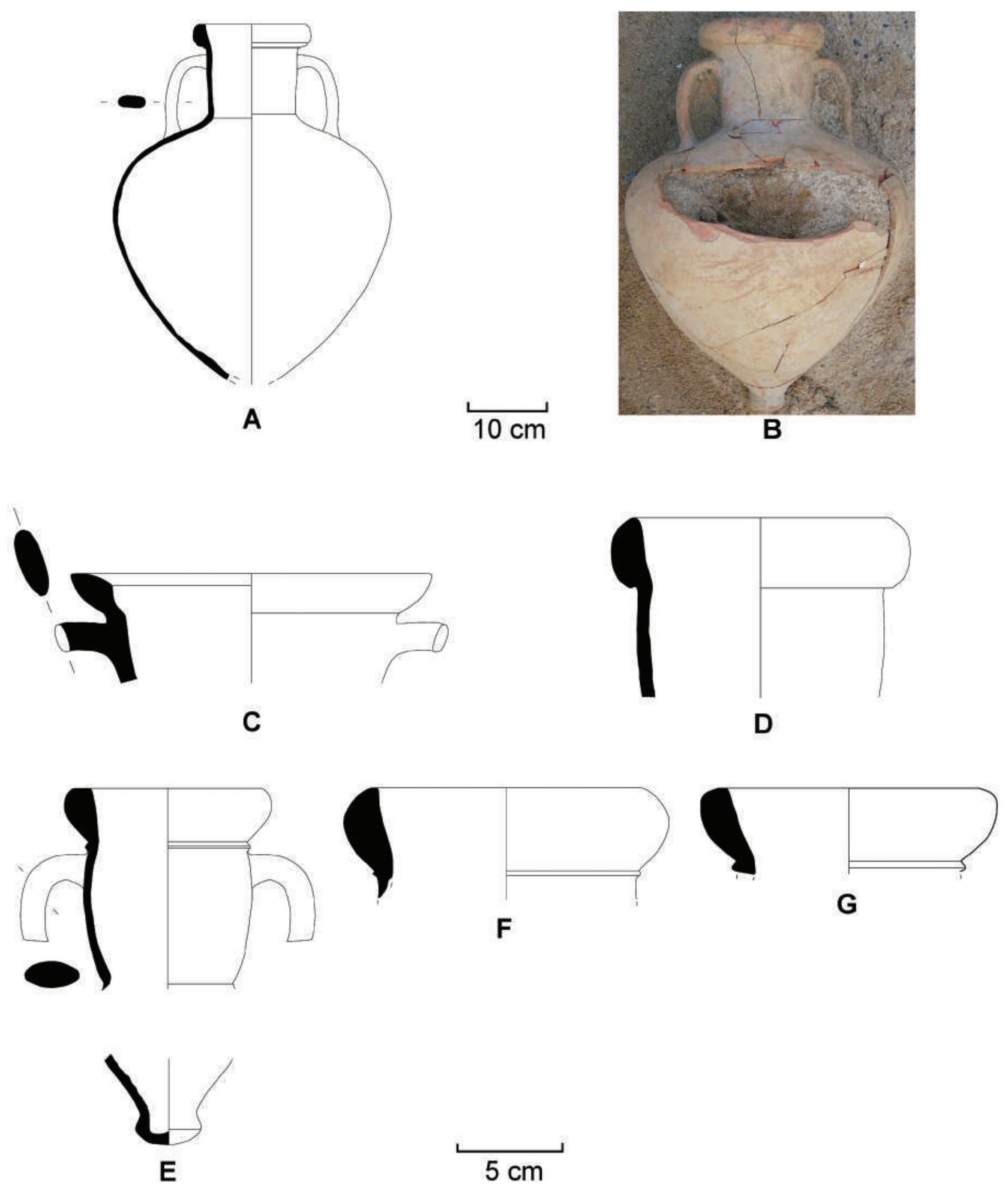

Fig. 4.- Western Greek amphorae of Selinunte. A-B: form 2; C: *Randform* 5; D: *Randform* 2/6; E-F: *Randform* 7.

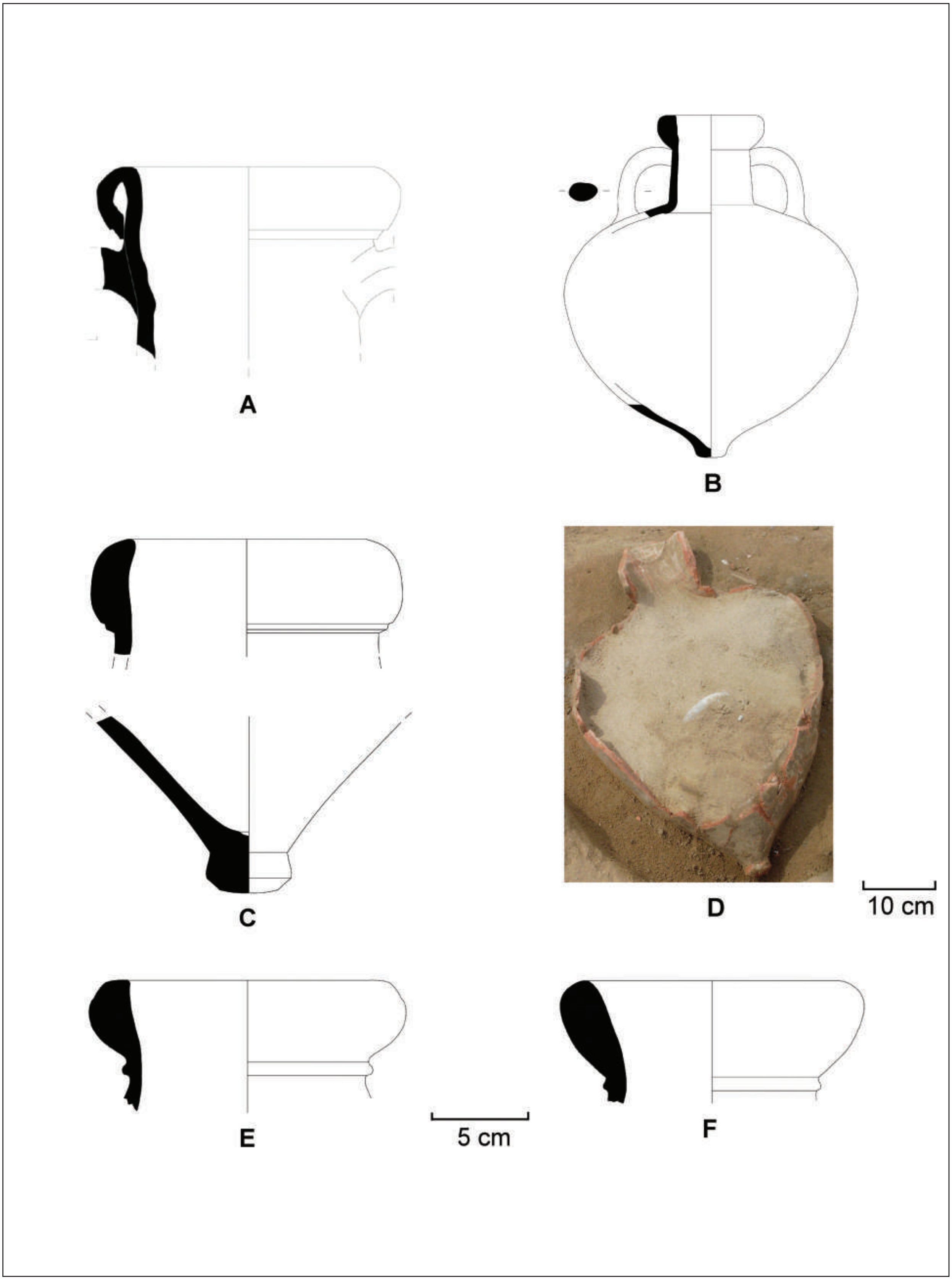

Fig. 5.- Western Greek amphorae of Agrigento. A-B: *Agrigento* 1; C-D: *Agrigento* 2; E-F: *Randform* 7.

in the whole regional context of western Sicily and in Carthage's sphere of influence[16]. This evidence is in perfect harmony with the ancient sources which underline Agrigento's preeminent wine trade.

3. Results and discussion

In presenting and discussing the minero-petrographic and chemical peculiarities found in the western Greek amphorae produced in *Himera*, Selinunte, and Agrigento, it is considered appropriate, at the same time, to describe the textural and compositional key characteristics of the clayey raw materials whose use has been established in each of these sites.

The 'ceramic clays' of western Sicily are chiefly distributed in the geochronological interval between the Oligocene and the Middle Pleistocene (Montana *et alii* 2011). They were continuously and diachronically used in this territory to produce ceramic artifacts from the Neolithic until the 1950s. The depositional environment of these syntectonic terrigenous formations, although evolving over a relatively wide interval of geological time (Alpine orogeny), remains substantially comparable. With reference to the production process and the optimal characteristics of a specific ceramic raw material, this means that the individual clayey lithologies concerning both the sand-sized aplastic inclusions and the finer groundmass, are characterised by rather similar characteristics in terms of textural aspects (i.e. packing, size, grade of roundness) and mineralogical aspects (i.e. phyllosilicates speciation and ratio of abundance, nature and relative frequency of monomineralic granules or lithic fragments that characterize the sand-sized aplastic components). The 'confusion' may even be increased by other aspects intrinsic to the geological nature of these detrital deposits, sedimented in the sea and subject to the variability, over geological time, of the contributions from the emerged areas. For this reason, it is always a good practice, to increase the significance of the experimental data, to sample the materials (to be subjected to analysis) sequentially, from the bottom to the top, of the chosen stratigraphic section and/or in different outcrop points. Overall, therefore, this circumstance could make the distinction between the ceramic bodies made starting from such clayey materials more and more multifaceted, especially if, for aspects mainly linked to the specificity of the finished ceramic product, they are further transformed during the production chain (i.e. clay mixing and/or tempering) or the firing step (i.e. maximum temperature reached and residence time, oxidizing or reducing atmosphere in the kiln).

Despite these objective difficulties, common to several other case studies, the observations of thin-section at the polarizing microscope first enabled to confirm that the selected amphorae can be attributed to 'local' ceramic production that employed raw clays sourced nearby each of the three archaeological sites. Certainly, the application of an integrated archaeometric approach, conceived and developed over twenty years ago within the international project GEOPRO[17], has made it possible to overcome a good part of these obstacles and to discriminate different markers (mineralogical, chemical, and textural) useful for attesting the raw materials used and therefore identify the different production centers even in relatively restricted territorial contexts. The

16 See specifically Montana *et alii* 2022: fig. 3. Currently, more than 30 western Greek amphorae of Agrigento have been identified in Greek colonies (Selinunte, *Himera*), in Sicilian native sites (Segesta, Terravecchia di Cuti), and in Punic sites (Pantelleria, Rabat/Malta).

17 GEOPRO: TMR European Interdisciplinary Network Project under the 4th Framework Program (1999-2002) which had as its object the joint archaeometric analysis of archaeological ceramics and clay raw materials using minero-petrographic and chemical techniques appropriately integrated on a geological and statistical basis.

ceramic raw material, for each individual case study, was deeply recognised without any doubt among all the clayey deposits outcropping in the same territory, thanks to any specific geological fingerprint and through an in-depth cross-comparison of the textural and compositional characteristics, after experimental firing at various temperatures (under oxidizing atmosphere).

Below are reported the descriptions of the micro-fabrics attested in the western Greek amphorae produced in *Himera*, Selinunte, and Agrigento, which were individually determined in previous papers (Montana *et alii* 2018a; 2018b; 2022; forthcoming; Montana, Randazzo and Bechtold 2020). The corresponding average chemical compositions are discussed in succession, having been interpreted geochemically, in light of regional geology as well as the mineralogical phases and lithic fragments characterising each single ceramic paste (also considering accessory components and extent of 'burial contamination').

3.1. Thin-section Petrography

3.1.1. Himera

The observations of the thin sections of the samples representative of the western Greek amphorae produced in *Himera*, selected on the basis of their macro-fabrics, first of all allowed us to demonstrate the use of the illitic-kaolinitic clays of the Terravecchia Formation (upper Tortonian-Messinian). These materials are certainly those that, in the considered area, were preferentially selected for pottery manufacturing (Montana *et alii* 2011; forthcoming). They may be categorised as silty-clays with a poor sandy fraction, which is on average the 8% by weight. The sand-sized natural inclusions are characterized by a relatively scarce calcareous fossil microfauna and they are essentially composed of quartz, feldspars and tiny mica flakes. These peculiar (textural and compositional) characteristics make these clays very appropriate for direct processing, without preliminary sieving, levigation or tempering treatments. This technological aspect could explain the wide use that was made of these clays where available in the surrounding area, in the archaic and classical ages. The use of these clays as 'raw materials for ceramic use' has so far been attested in various sites of western Sicily, including Segesta (Montana *et alii* 2003), Monte Polizo (Montana *et alii* 2012), Entella (Montana, Polito and Tsantini 2015; Montana *et alii* 2017) and somewhat also at Monte Iato (Montana *et alii* 2021).

Specifically, after the thin-section observation at the polarizing microscope, the micro-fabric of the western Greek amphorae made at *Himera* presents peculiar and fairly homogeneous characteristics, except for some slight textural discrepancies, such as those concerning packing and grain-size distribution of the aplastic granules, which, however, led back to single raw material source. The most frequent paste (attested on over two-thirds of the examined ceramic samples) can be recognized by the strong prevalence of very fine aplastic inclusions mostly falling in the coarse silt class (0.04-0.06 mm). Fine to medium sand-sized inclusions (0.1-0.3 mm) are very rare. Packing is overall moderate turning out to be between 3% and 5%. Grain sorting is serial and the groundmass is optically inactive, showing only sporadic clay lumps. The aplastic inclusions are mainly composed of monocrystalline quartz, followed by visibly minor quantities of polycrystalline quartz, white mica needles (homogeneously dispersed in the ground-mass) and feldspars. Small lithic fragments (granitoid rocks, quartzarenite/quartzsiltite) are relatively rarer (few granules) or even absent. The calcareous microfossils (or their residues after the firing process) are in general sporadic, while, occasionally, secondary 'burial calcite' may be disseminated in pore space of the ground-mass, or else in the form of a very thin covering layer in the external parts of the ceramic fragment (Fig. 6).

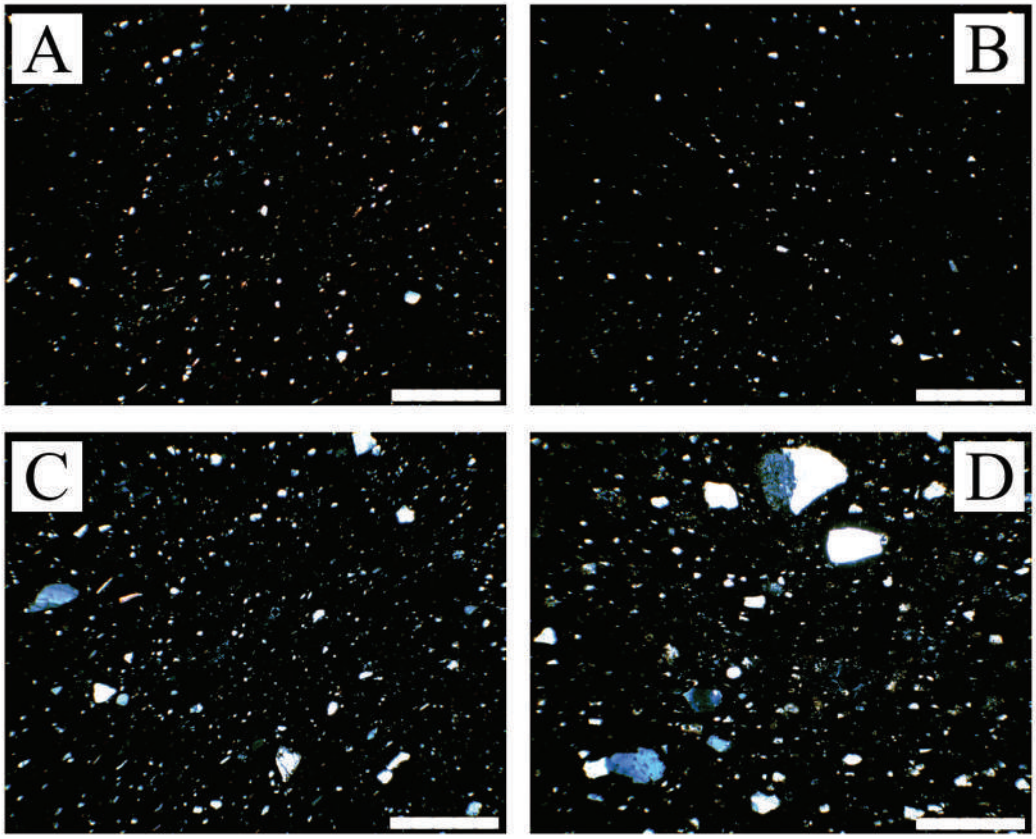

Fig. 6.- Thin section micro-photographs of the western Greek amphorae produced at *Himera* highlighting their main textural and compositional features (XPL; scale bar = 0.5 mm).

This technological aspect could explain the wide use that was made of these clays where available in the surrounding area, in the archaic and classical ages. As mentioned above, quite slight textural variations (with respect to the previous description) have been occasionally observed in part of the amphora samples (around 30%). A relatively greater abundance of fine or medium sand inclusions (respectively 0.125-0.25 mm and 0.25-0.5 mm), a higher packing (up to 10-15% area) and a bimodal (hiatal) distribution of the aplastic inclusions, being the classes of very fine sand and medium sand distinctly more represented than coarse silt (0.04-0.06 mm) and coarse sand (0.5-1 mm).

3.1.2. Selinunte

As regards Selinunte, previous studies based on the direct comparison between archaeological ceramics and the clayey raw materials available in the same area, proved the use of the Plio-Pleistocene marine clay deposits belonging to the Marnoso Arenacea del Belice Formation (Montana *et alii* 2018a; 2018b; forthcoming; Montana, Randazzo and Bechtold 2020). The silty-clayey or clayey-silty deposits belonging to this formation mainly crop out in southern part of western Sicily. These materials are characterised by a medium-fine sand content around 11% by weight (average). Illite and kaolinite are once again the mineralogical phases predominant within the clay fraction, while smectite content (or I/S mixed layers) is generally below 20%. The sand-sized natural inclusions (0.06-2 mm) showed a slight prevalence of the calcareous components (macrofossils remains together with benthonic and planktonic foraminifera) over

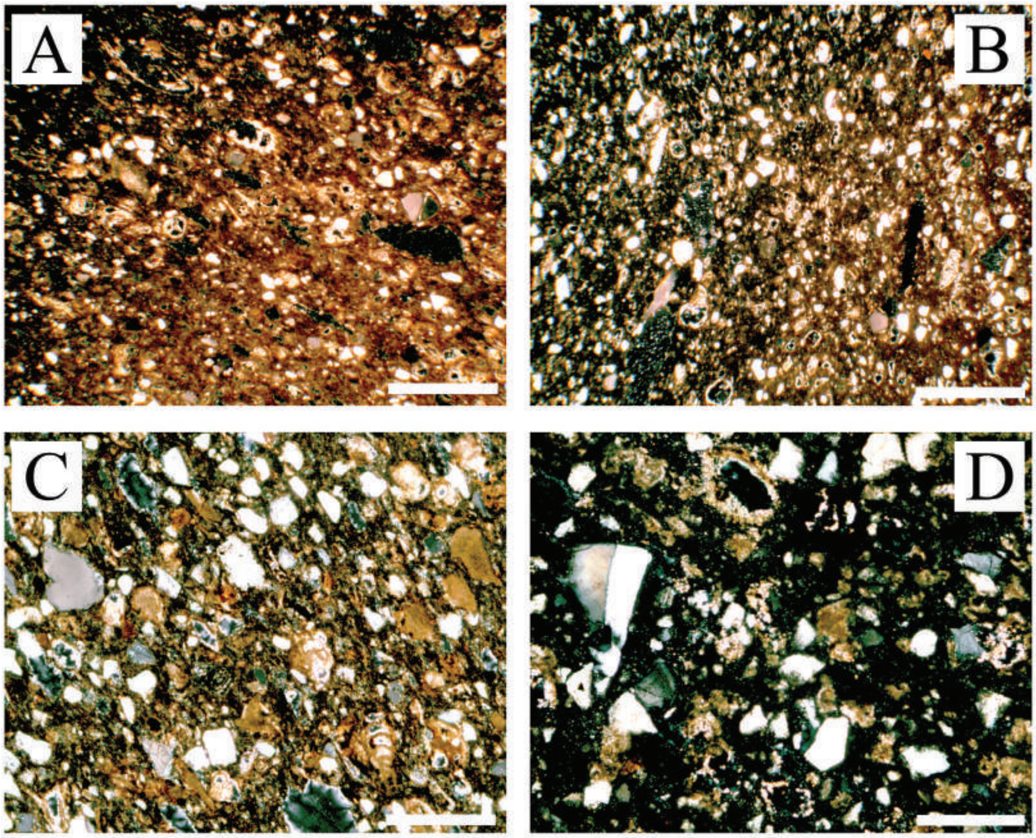

Fig. 7.- Thin section micro-photographs of the western Greek amphorae produced at Selinunte highlighting their main textural and compositional features of production (XPL; A-B: scale bar = 0.5 mm; C-D: scale bar = 0.2 cm).

quartz, feldspars and acid crystalline lithic fragments. The use of these materials for ceramic purposes has a long tradition, especially in this territory. Particularly relevant examples have been also attested at Monte Adranone (internal indigenous settlement located in the Sicani mountains) and Marsala (Montana *et alii* forthcoming).

The whole set of representative western Greek amphorae showed acceptable uniformity in terms of minero-petrographic features. They fully reflect the key characteristics of local clayey raw materials, both in terms of grain size distribution and relative abundance of the aplastic inclusions as well as the mineralogical composition (Montana *et alii* 2018a; 2018b). Going into details, as regards the textural aspects, the analysed amphoras show serial distribution of aplastic inclusion size and a relative abundance between 15 and 25% (area), with a notable predominance of coarse silt (0.04-0.06 mm) and very fine sand (0.06-0.125 mm) and lesser amounts of fine sand (0.125-0.25 mm). Inclusions with dimensions ranging from the upper limit of fine sand (0.25 mm) and medium sand (0.5 mm) are sporadic to common; while aplastic grains with diameter greater than 0.5 mm are rare or even absent. Concerning the mineralogical composition, monocrystalline quartz appears to be by far the most abundant component. Bioclasts and limestone fragments are both common constituents, even if they are almost decomposed after undergoing the firing process, thus suggesting firing temperatures above 800°C. However, their remains are still evident in the form of 'micrite clots', sometimes with a sub-rounded profile, or more often with an irregular shape (Cau Ontiveros, Day and Montaba 2002). Polycrystalline quartz and feldspars (K-feldspar and less frequently plagioclase) are common to sporadic components. Very often the crystals of alkaline feldspar and plagioclase appear, especially in the rim, altered showing incoming transformation in clay (sericite). Among the subordinate or trace constituents fragments of sandstones were also recognized, together with mica (chiefly 0.04-0.1 mm in size), in the form of lamellae and needles. Secondary deposits of microcrystalline calcite are quite common, which developed during the burial phase both in the external rim and in the ceramic body (Fig. 7).

The clays of the Marnoso Arenacea del Belice Formation crop out extensively all around the settlement of Selinunte. The easy availability, good plasticity and workability at the natural state, as well as the presence of a consistent (but not excessive) calcareous component, made this raw material optimal for amphora and daily-use pottery production. Moreover, especially for the manufacture of bricks and/or cooking ware, the same clays were also tempered with medium-fine grained sand, likely sourced in the nearby coastal dunes (Montana *et alii* 2018a; 2018b).

3.1.3. Agrigento

From a lithological point of view, the territory of Agrigento is characterised by the occurrence of upper Miocene evaporitic deposits covered by Plio-Pleistocene marly clay and biocalcarenites (Catalano *et alii* 2013). In particular, the area of the *Valle dei Templi* is characterised by the widespread presence of grayish clays widely emerging lengthwise the slope and in the plain below the temples. These lower Pleistocene marine clays, characterized by remains of calcareous microfossils (mainly planktonic foraminifera and mollusks), have been recently established to be the ceramic raw material used for local production of western Greek amphorae (Montana *et alii* 2022). Their clay-sized fraction resulted mainly composed of illite and kaolinite with negligible quantities of swelling clay minerals (i.e. smectite and I/S mixed layers). In terms of granulometry the lower Pleistocene Agrigento clay can be classified as silty-clay or clayey-silt, with quite negligible sand content (ranging from 2 up to 17% weight, average 8%). Natural inclusions mainly fall in the classes of coarse silt (0.04-0.06 mm) and very fine sand (0.06-0.125 mm) with sporadic to rare medium-coarse sand sized individuals (0.25-1 mm). The most abundant mineralogical phase is monocrystalline quartz. Calcareous microfossils are also common constituents, while polycrystalline quartz, mica flakes, feldspars and gypsum are less common to sporadic/rare.

The micro-fabric of the western Greek amphorae produced in Agrigento is accordingly characterized by abundant minute aplastic inclusions (packing ranging from 10% to around 20% area), ranging in size from coarse silt and fine sand (0.06-0.25 mm). Granules greater than 0.3 mm are sporadic to rare. In terms of composition, the calcareous component (common) is represented by bioclasts (frequently decomposed due to the firing process) and micrite clots (Cau Ontiveros *et alii* 2002). Monocrystalline quartz is clearly prevailing over polycrystalline quartz, mica flakes and feldspars (Fig. 8). Glauconite and iron oxides/hydroxides are sporadic accessory constituents scattered in the groundmass as lumps (with irregular or subcircular form) resulting from the aggregation of particles with very small dimensions (colloids). Moreover, massive or fibrous aggregate of anhydrite ($CaSO_4$) can be occasionally detected, distinguishable under the polarizing microscope by the high interference color, the perfect (010) cleavage and the absence of pleochroism (colorless at plane polarised light). The presence of this phase, although not frequent, may represent a peculiar 'minero-petrographic marker' of the amphorae produced in Agrigento. In fact, it was demonstrated that tiny anhydrite crystals originate during the ceramic 'firing stage' from the calcination of gypsum

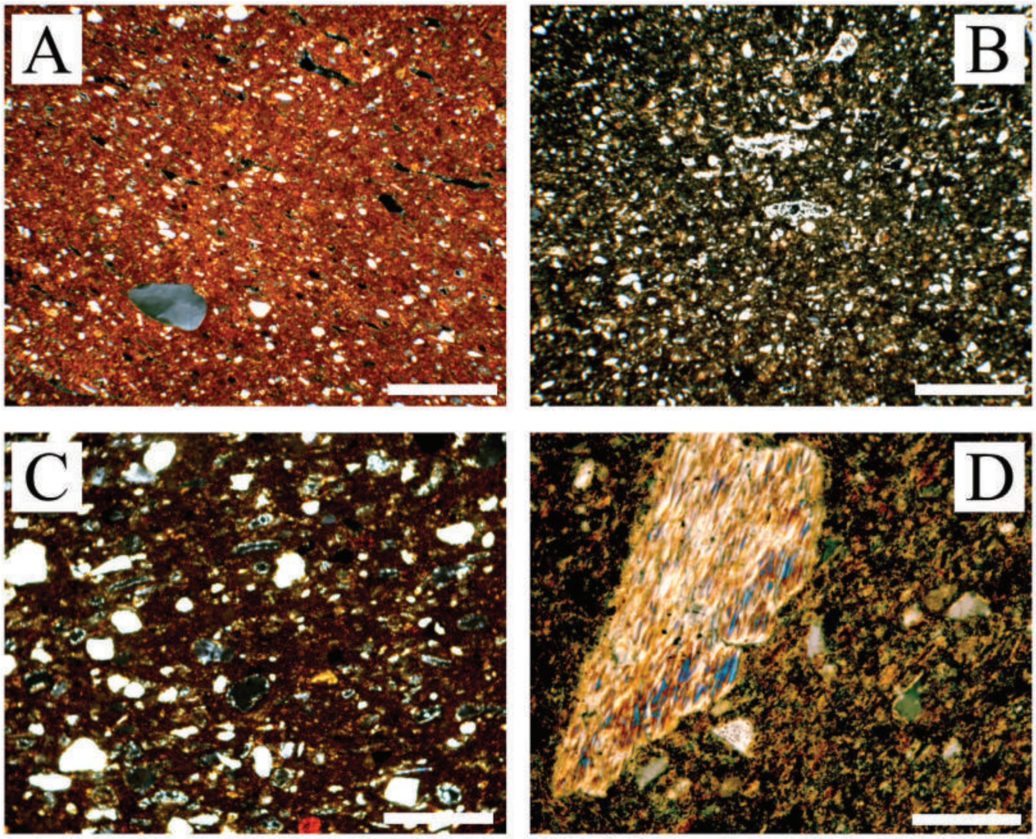

Fig. 8.- Thin section micro-photographs of the western Greek amphorae produced at Agrigento highlighting their main textural and compositional features. Anhydrite crystal is shown in figure 8D (XPL; A-B: scale bar = 0.5 mm; C: scale bar = 0.2 cm; D: scale bar = 0.1 mm).

($CaSO_4.2H_2O$), which was detected by XRPD analysis as subordinate crystalline phase in the raw clays sampled in the *Valle dei Templi* (Montana *et alii* 2022). The clays of Agrigento may contain small quantities of detrital gypsum (fragments of selenite gypsum) very likely deriving from Messinian evaporitic deposits.

3.2. Chemistry

The chemical analysis of a ceramic body has been considered for over thirty years an indispensable tool for defining 'compositional groups' that are a reference for recognising and circumscribing a given ceramic production. Provenance studies of archaeological ceramics by the analysis of their bulk chemical composition are based on the assumption that pottery manufactured in different production centres can be distinguished thanks to the different clay raw materials used. Clay pastes for the manufacture of ceramics were prepared from natural raw materials commonly extracted in the vicinity of the production sites (Hein and Kilikoglou 2020). Obviously, the nature (i.e. relative abundance of the different grain size fractions, mineralogical composition and size distribution of the sandy inclusions) depends on the specific formation processes of the clay deposits themselves and on the different regional geological contexts. Furthermore, it should be considered that, given the same raw material used, the different preparation procedures for the clay mixture should also be considered, i.e. the purification treatments necessary for natural clays that are too lean and the tempering treatments for those that are too plastic, which could make direct comparison with finished ceramic products more complex. Especially in these cases, the integrated archaeometric approach, previously mentioned, which involves the interpretation of the chemical data always in the light of the minero-petrographic data, allows the ceramic production centers to be characterised in a much more detailed way.

3.2.1. Himera

The western Greek amphorae manufactured in *Himera* with the clays of the Terravecchia Formation show quite distinctive chemical characteristics, at least in the panorama of contemporary Sicilian productions, both in terms of some major elements and trace elements. As previously pointed out, the petrographic analyses of the finds highlighted only slight textural differences within this 'paste group', essentially linked to the relative abundance and size of the aplastic inclusions, mainly composed of quartz, feldspars and mica. Therefore, the average bulk chemical composition reported in Figure 9 (together with those of Selinunte and Agrigento) can be considered satisfactorily representative of local productions. First of all, the rather low content of calcareous microfossils which characterize the Terravecchia Formation clay deposits (raw materials) means that the average concentrations of CaO in the amphorae produced in *Himera* are accordingly quite modest (variable between approximately 7 and approximately 10% by weight, with an average of 8.83% by weight). At a regional level in the clays of the Terravecchia Formation, average concentrations of around 5% by weight have been measured in the basal outcrops of the Tortonian which become between 7 and 10% in the middle-upper Tortonian. The levels of the same formation that can be dated to the Messinian (upper Miocene), however, can reach decidedly higher CaO concentrations (up to 24% by weight) following the common presence of gypsum crystals ($CaSO_4.2H_2O$) within the same clayey deposits (Montana *et alii* 2011). Thus, the western Greek amphorae produced in *Himera* are characterised by a SiO_2/CaO ratio of 6.6. Additionally, the average concentrations of Al_2O_3, Fe_2O_3 and MgO (respectively equal to 18.04%, 7.25% and 3% by weight, see the first column on the left in Figure 9) found in the amphorae produced in *Himera* are relatively abundant as found by chemical analysis on more than 150 samples collected from 23 different outcrops of the Terravecchia Formation clays (Montana *et alii* 2011). Relative to the ceramic bodies under study, these values are explained by the low abundance as well as small size of the quartz inclusions dispersed in the plastic clay groundmass (dilution effect). Similarly, the relatively high values of the average concentrations of K_2O (2.54% by weight) and TiO_2 (0.92% by weight), among the major elements, as well as of Rb (101 ppm), among the trace elements, are to be correlate to the rather common presence of minute lamellae of white mica, as attested by observations of thin sections under a polarizing microscope. Among the trace elements, the average contents in V (128 ppm), Ba (518 ppm), La (42 ppm) and Ce (85 ppm) can also be considered as peculiar compositional marker, once again well-interpretable in light of the mineralogical and petrographic characteristics of the ceramic pastes.

3.2.2. Selinunte

The chemical composition of the western Greek amphorae produced at Selinunte fits more than satisfactorily the results obtained by the observations of thin sections at the polarizing microscope, also confirming the use of the clay deposits (Quaternary) outcropping very close to the kilns area. The small variations in concentration recorded both for major and trace elements can be linked to minor changes in packing and size distribution of the aplastic inclusions. In fact, no relevant differences concerning nature and relative abundance of minerals or lithic fragments composing the aplastic inclusions have been pointed out (Montana *et alii* 2018a; 2018b).

As shown in the Figure 9 (central column). The average value of the SiO_2 concentration measured in the western Greek amphorae produced in Selinunte is rather high in general (58.18% weight) and it is slightly below that recorded in the contemporary productions of Agrigento (59.18% weight) and to some extent higher than the average value of the amphorae produced in *Himera* (57.90% by weight). The average concentration of CaO (16.09% by weight), on the contrary, is the highest among the western Greek amphorae production centers of Sicily. Consequently, the SiO_2/CaO abundance ratio also allows us to clearly distinguish the Selinuntian manufactures from the others, being equal to 3.6 and therefore visibly lower (*Himera*=6.6 and Agrigento=4.1).

The average abundance of Fe_2O_3 is 5.84%, a value slightly lower than the average value previously recorded for the "ceramic clays" of western Sicily (Montana *et alii* 2011). The concentrations of the oxides corresponding to the other major elements (Al_2O_3, MgO and K_2O) are absolutely compatible with the mineralogical composition and relative abundance of the monomineralic grains and rock fragments composing the aplastic inclusions, reflecting the smaller quantities of magnesium-bearing, opaque oxides, feldspars and silt-sized mica. Considering the abundances of trace elements, it should be noted that the concentration ranges of V, Rb, Ba and Sr appear well correlated with the abundances of the geochemically linked major elements (Fe, K and Ca). As can be seen from Figure 9, apart from the SiO_2/CaO ratio and the K_2O content, as regards the concentrations of the major elements, the Agrigento and Selinunte amphorae are relatively similar. This result is not surprising given that the clay raw materials used at the two sites are very close from the point of view of geological age and depositional environment (Montana *et alii* 2022). However, small mineralogical differences (mica relatively more abundant in Agrigento compared to Selinunte and consequently also the concentrations of K_2O and Rb) and also in the type and abundance of calcareous microfossils, can allow us to discern the two productions with sufficient margin of certainty (Montana *et alii* 2022). Figure 10 shows some binary diagrams that relate the major and most significant trace elements for the purposes of differentiating the three amphorae productions. As can be seen, the Rb-K_2O scatter plot is the only one that allows us to discriminate quite effectively, from a chemical point of view, the western Greek amphorae from Agrigento and those from Selinunte, while the *Himera* productions always stand out clearly from the others.

3.2.3. Agrigento

The average bulk chemical composition of the western Greek amphorae from Agrigento (Figure 9, right column) fits very well both with the production wastes found during recent excavations in the kilns area and with the clayey raw materials sampled in the vicinity belonging to the Agrigento Formation (Montana *et alii* 2022). The amphorae are chemically characterised by a high SiO_2 value, close to 60% by weight (on average equal to 59.18%), contrasted with an average CaO concentration equal to 14.50% (weight), decidedly higher than that found in the contemporary *Himera* productions. On the contrary, again compared to the *Himera* case, relatively lower average values of Al_2O_3, Fe_2O_3 and MgO were recorded (respectively equal to 13.89%, 5.89% and 2.38% by weight). Also, regarding the concentrations of K_2O and TiO_2 the values are a little lower if compared to *Himera* (on average 1.96% and 0.79% by weight respectively). However, these values fully reflect the mineralogical composition found through microscopic observations and XRD analyzes, which highlighted the presence of sporadic feldspars (both

K-feldspar and plagioclase) and tiny mica flakes within the fine aplastic inclusions (Montana *et alii* 2022). Still among the major elements, it is important to point out the relatively high value of average sodium concentration in the ceramic body (on average 0.97%), also found in the local clayey raw materials, which is distinctly different from the average values found in the majority of 'ceramic clays' from western Sicily (Montana *et alii* 2011). The cause of this odd value, therefore potentially usable as a marker of provenance, at least in a regional context, can be sought in the presence in the local clays of detrital contributions of evaporitic materials deriving from the Gessoso-Solfifera Formation of the upper Miocene (Schreiber *et alii* 1976), as already pointed out by petrographic analyzes with the presence of calcium sulphate crystals (anhydrite) both in the clays (after experimental firing at 700°C and 900°C) and, more sporadically, also in the corresponding ceramic artifacts. In this regard, some reflection should also be placed on the CaO content of these ceramic materials (on average 14.50% by weight). The data deriving from polarising microscope observations, in fact, does not fully support such a concentration, given that the local clays, of marine origin, are characterized by the prevalence of fossil planktonic organisms with a calcareous shell, very small in size, over the benthic ones and macrofossils (fragments of lamellibranchs, coral, gastropods, algae, etc). Such a concentration of CaO is justified by considering the presence of small but not negligible quantities of gypsum ($CaSO_4.2H_2O$) in the local clays which then, following firing, transforms into anhydrous calcium sulphate (Montana *et alii* 2022). The trace elements, in terms of concentration, as logically expected, fully reflect the trends and correlations detected in the geochemically similar major elements (see Figure 9) and the relative abundances of the accessory mineralogical phases found through the study of thin sections under a polarizing microscope.

Element oxide (wt%)	Himera	Selinunte	Agrigento
SiO_2	57.90	58.19	59.18
Al_2O_3	18.04	13.92	13.94
$Fe_2O_{3(T)}$	7.25	5.84	5.89
MgO	3.00	2.24	2.38
CaO	8.83	16.09	14.50
Na_2O	1.22	0.86	0.97
K_2O	2.54	1.65	1.96
TiO_2	0.92	0.82	0.79
Element (ppm)	Himera	Selinunte	Agrigento
V	128	100	103
Ba	518	407	418
Sr	394	641	575
Zr	188	266	238
Cu	35	21	22
Zn	113	76	86
Rb	101	57	74
La	42	37	35
Ce	85	73	70

Fig. 9.- LOI normalized average chemical composition of the amphorae produced at *Himera*, Selinunte and Agrigento.

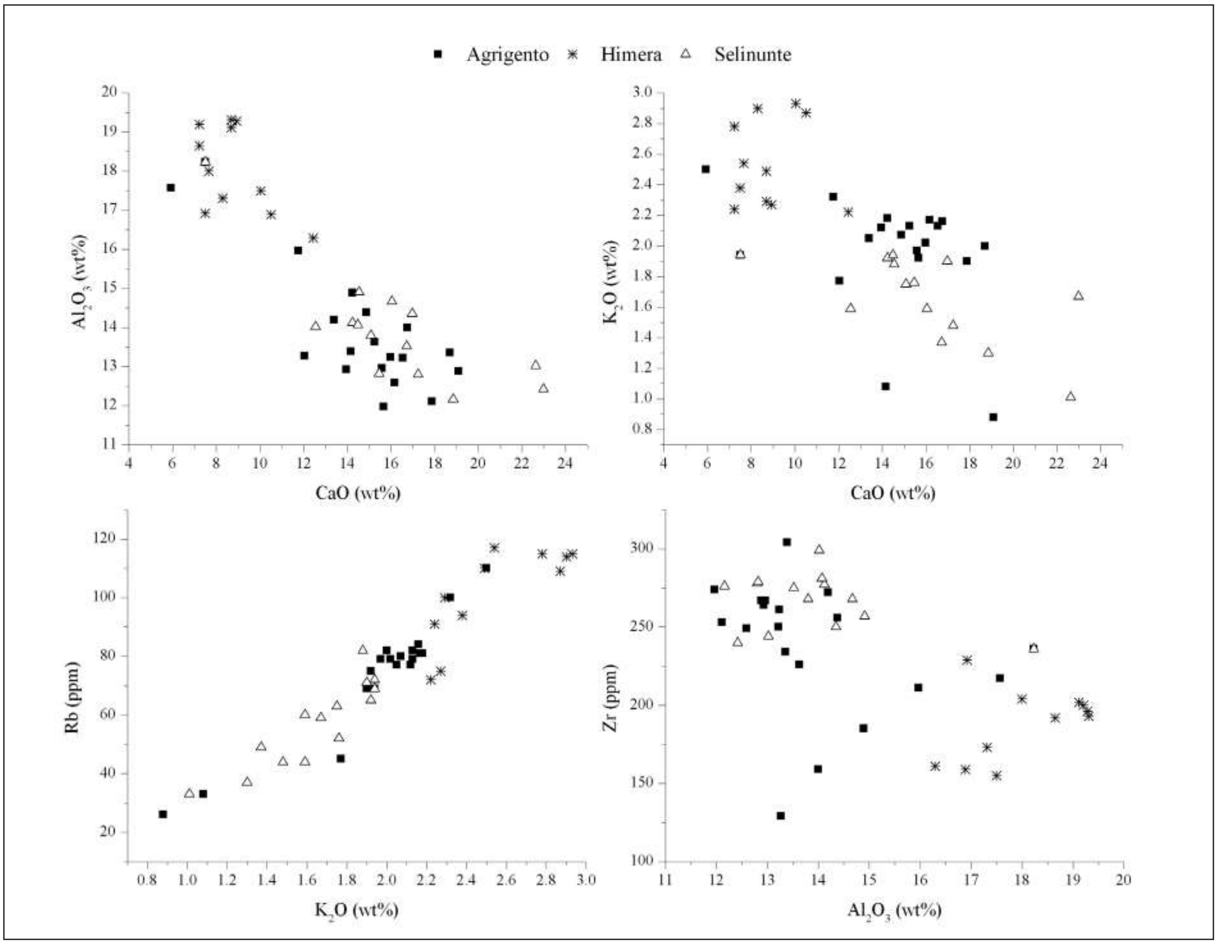

Fig. 10.- Binary plotting where the concentrations of some major and trace elements are shown, which are particularly significant for the purposes of differentiating between the amphorae productions under study (*Himera*, Selinunte, and Agrigento).

4. Conclusions and perspectives for further research

Recent high-standard provenance studies under the umbrella of multidisciplinary collaboration[18] allowed for the almost complete characterisation of western Sicily's amphorae series produced from the Archaic to the early Hellenistic period[19]. The overall results of these investigations represent a benchmark for a nuanced understanding of regional economic development[20] and commercial interaction between Greek, Phoenician-Punic, and native communities in this frontier area[21] situated in the western part of the island.

18 Following Gliozzo's (2020: 15) plea for the establishment of a 'M(acro and)M(icro)-typology' for solid past reference groups based on geo-chemical and minero-petrographic analyses.

19 For the panorama of the Sicilian Phoenician-Punic amphorae series, see Bechtold 2015; Montana and Randazzo 2015; Bechtold and Vassallo 2018. For the early Hellenistic series of Entella, see Corretti and Michelini 2020.

20 In Antiquity, the setting-up of transport container manufacturing installations implies the availability of an agricultural *surplus* destined for extra-local markets (Sourisseau 2011: 146-147).

21 For this panorama of multi-ethnic interaction, see latest Spatafora 2015 and 2018, with earlier references.

As for the Greek colonies, the earliest western Greek series was set up in *Himera*. The local production of transport vessels suggests a profit-orientated exploitation of the resources cultivated in the *chora,* already evident shortly after the mid-6th century BCE. In the late Archaic period, amphorae manufacturing spread quickly, testifying to widespread welfare in the whole region[22]. From a typological standpoint, during this earlier phase, Sicilian potters imitated amphorae shapes produced in the areas of Sibari, Reggio, and Locri in Calabria[23]. Significantly, southern Calabrian vessels are best documented in almost all Archaic-period archaeological contexts of western Sicily[24].

With the possible exception of the *Akragas* series, it appears that the aforementioned western Greek series were predominantly distributed within the non-Greek *milieu* of the colonies' hinterlands. In light of the primary focus of the present volume, we do not expect to find significant quantities of Sicilian western Greek amphorae at Iberian sites[25]. However, we should keep in mind the fundamental role central Mediterranean commercial hubs such as *Himera* play within the wider framework of long-distance routes, likely involving 'international' trade to and from the West[26]. We cannot, therefore, rule out the possibility that local commercial agents introduced single western Sicilian Greek amphorae among the cargoes in transition at such ports of call. Promising ongoing research in the settlements of the Iberian Peninsula will shed more light on this challenging question.

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22 For this phenomenon, see Vassallo 2020 with earlier references.
23 In detail, see Bechtold 2020a: 5-7, fig. 3.
24 Bechtold and Vassallo 2023: 153-164. Fully in line with the fact that the choice of vessel types is closely related to the amphorae repertoire already in circulation within the regional context (Gassner 2015: 346-347).
25 The multidisciplinary analyses of the amphorae from the shipwreck of Cala Sant Vicenç at Mallorca (Nieto and Santos 2008) might suggest, in fact, the wide-spread distribution of the Calabrian series also in the West.
26 We highlight the considerable presence of southern Andalusian fishery-containers in the colony (Bechtold and Vassallo 2018: 39-41).

References

Albanese Procelli, R. M. 1996: Appunti sulla distribuzione delle anfore commerciali nella Sicilia arcaica, *Kokalos* XLII, Pisa-Roma, 91-137.

Albanese Procelli, R. M. 1997: Échanges dans la Sicile archaïque: amphores commerciales, intermédiares et redistribution en milieu indigène, *Revue Archéologique* 1, Paris, 3-25.

Albanese Procelli, R. M. 2021: Sistemi di stoccaggio delle derrate nella Sicilia indigena in età arcaica, *Sicilia Antiqua* XVIII, Pisa-Roma, 29-36.

Bechtold, B. 2015: *Le produzioni di anfore puniche della Sicilia occidentale (vii–iii/ii sec. a.C.) (con i contributi di Giuseppe Montana, Luciana Randazzo e Karin Schmidt), Carthage Studies* 9, Ghent University, Ghent.

Bechtold, B. 2020a: Western Greek amphorae produced at Himera, in: *FACEM* (version December/06/2020) https://www.facem.at/project-papers.php

Bechtold, B. 2020b: First evidences for western Greek amphorae produced at Selinus, in: *FACEM* (version December/06/2020) https://facem.at/project/papers.php

Bechtold, B. 2020c: First observations on western Greek amphorae produced at Akragas, in: *FACEM* (version December/06/2020) https://facem.at/project/papers.php

Bechtold, B. 2021: Le anfore da trasporto di età classica e tardoclassica dal santuario maggiore sull'acropoli di Selinunte: primi dati, in: Ployer, R. and Svoboda-Baas, D. (eds.), *Magnis Itineribus. Festschrift für Verena Gassner*, Wien, 37-54.

Bechtold, B. 2022: Studi di provenienza sulle anfore greco-occidentali e anfore greco-italiche, in: Caliò, L., Gerogiannis, G. M., Leoni, F. and Raimondi, G. (eds.), *Agriento 2. Il santuario ellenistico-romano. Scavi 2013-2017. I materiali*, Studi Agrigentini 2, Roma, 427-439.

Belchold, B. and Burgio, A. forthcoming: Anfore da trasporto come indicatori di rapporti commerciali nella Sicilia centro-settentrionale (vi-iv sec. A. C.): il contributo del sitio indigeno di Terravecchia di Cuti (PA), *Thiasos*, Roma.

Bechtold, B. and Vassallo, S. 2018: Le anfore puniche dalle necropoli di Himera (seconda metà del vii–fine del v sec. a. C.) (con i contributi di D. Braekmans, R. de Simone, S. Gupta, G. Montana, L. Randazzo and K. Schmidt), *BABESCH. Annual Papers on Mediterranean Archaeology Supplement Series* 34, Leuven.

Bechtold, B. and Vassallo, S. 2023: Le anfore greco-occidentali dalle necropoli di Himera (vi-v sec. a.C.): produzioni e circolazione (con i contributi di G. Montana, L. Randazzo and T. Sommerschield), *BABESCH. Annual Papers on Mediterranean Archaeology Supplement Series* 49 [in press], Leuven.

Bechtold, B., Vassallo, S. and Ferlito, F. 2019: La produzione delle anfore greco-occidentali di Himera: uno studio sulla loro identificazione, *Notiziario Archeologico Soprintendenza Palermo* 51, Palermo. https://www.regione.sicilia.it/beniculturali/dirbenicult/NotiziarioArcheoPalermo.html

Brun, J.-P. 2010: Viticulture et oléiculture grecques et indigènes en Grand Grèce et en Sicilie, in: Tréziny, H. (ed.), *Grecs et Indigènes de la Catalogne à la Mer Noir*, Bibliothèque d'Archéologie Méditerranéenne et Africaine 3, Paris, 424-431.

Brun, J.-P. 2011: La produzione del vino in Magna Grecia e in Sicilia, *La vigna di Dioniso: vite, vino e culti in Magna Grecia, Atti del quarantanovesimo Convegno di studi sulla Magna Grecia* (Taranto 2009), Taranto, 97-142.

Catalano, R., Valenti, V., Albanese, C., Accaino, F., Sulli, A., Tinivella, U., Gasparo Morticelli, M., Zanolla, C. and Giustiniani, M. 2013: Sicily's fold/thrust belt and slab rollback: The SI.RI.PRO. seismic crustal transect, *Journal of the Geological Society* 170, London, 451-464.

Cau Ontiveros, M. A., Day, P. M. and Montana, G. 2002: Secondary calcite in archaeological ceramics: evaluation of alteration and contamination processes by thin section study, in: Kilikoglou, V., Hein, A. and Maniatis, Y. (eds.), *Proceedings of the 5th European Meeting on Ancient Ceramics (Athens, 18-20 October 1999), Modern trends in scientific studies on ancient ceramics*, BAR International Series 1011, Oxford, 9-18.

Corretti, A. and Michelini, Ch. 2020: Entella (Contessa Entellina, PA). Produzioni locali e importazioni di anfore nella città e nel territorio (VI-inizio III sec. a.C.), in: *FACEM* (version December/06/2020) https://facem.at/project/papers.php

Gassner, V. 2003: *Materielle Kultur und Kulturelle Identität in Elea in spärchaisch-frühklassischer Zeit. Untersuchungen zur GefäB-und Baukeramik aus der Unterstadt (Grabungen 1987-1994)*, Archäologische Forschungen 8, Velia-Studien 2, Wien.

Gassner, V. 2015: Le anfore greco-occidentali: riconsiderando la loro evoluzione e l'identificazione dei centri di produzioni, in: Poure, R. (ed.), *Contacts et acculturations en Méditerranée occidentale. Hommage à Michel Bats* (Hyères 2011), Études Massaliètes 12, Aix-en-Provence, 345-356.

Gliozzo, E. 2020: Ceramic investigation: research questions and sampling criteria, *Archaeological and Anthropological Sciences* 12, New York, 202.

Hein, A. and Kilikoglou, V. 2020: Ceramic raw materials: how to recognize them and locate the supply basins: chemistry, *Archaeological and Anthropological Sciences* 12 (8), New York, 202. DOI:10.1007/s12520-020-01129-8.

Klug, R. D. 2013: *Griechische Transportamphoren im regionalen und überregionalen Handel. Untersuchungen in griechischen und nicht-griechischen Kontexten in Unteritalien und Sizilien vom 8. bis zum 5. Jh. v. Chr.* (J. Bergemann, ed.), Göttinger Studien zur Mediterranen Archäologie 4, Rahden/Westf.

Lawall, M. 2011: Socio-Economic Conditions and the Content of Amphorae, in: Tzochev, Ch., Stoyanov, T. and Bozkova, S. (eds.), *PATABS II. Production and trade of amphorae in the Black Sea* (Kitien, Nessebar and Sredetz 2007), Sofia, 23-33.

Matthew, A. J., Woods, A. J. and Oliver, C. 1991: Spots before your eyes: new comparison charts for visual percentage estimation in archaeological material, in: Middleton, A. P. and Freestone, I. C. (eds.), *Recent developments in ceramic petrology*, British Museum Occasional Paper 81, The British Museum, London, 211-263.

Montana, G. and Randazzo, L. 2015: Le ricerche archeometriche: la caratterizzazione delle produzioni di anfore punico-siciliane, in: Bechtold 2015, 118-146.

Montana, G., Polito, A. M. and Tsantini, E. 2015: Ceramic ethnoarchaeometry in Sicily: recent traditional production as a tool for understanding past manufactures, in: Militello, P. M. and Öniz, H. (eds.), *SOMA 2011: Proceedings of the 15th Symposium on Mediterranean Archaeology, held at the University of Catania, 3-5 March 2011*, BAR International Series 2695 (I), Oxford, 253-258.

Montana, G., Randazzo, L. and Bechtold, B. 2020: The beginning of western Greek amphorae production in western Sicily: archaeometric and archaeological studies on 6th-5th centuries BCE amphorae manufactured at Himera, *Minerals* 10, Basel, 762. DOI:10.3390/min10090762.

Montana, G., Randazzo, L. and Polito, A. M. forthcoming: Caratteristiche petro-chimiche delle argille della Sicilia occidentale ed istituzione di "reference group" per alcune produzioni ceramiche di interesse archeologico (Petro-chemical characteristics of the clays of western Sicily and establishment of a "reference group" for some ceramic productions of archaeological interest.), *Atti del Convegno "Selinunte–Convegno in occasione dei 50 anni di attività del DAI a Selinunte",* German Archaeological Institute in Rome, (aprile 2022), 27-29.

Montana, G., Bechtold, B., Polito, A. M. and Randazzo, L. 2018a: Selinunte (Sicily) and its productive context: the clayey raw materials applied in a long-lived ceramic production (seventh to third century BCE), *Journal of Archaeological and Anthropological Sciences* 10 (3), New York, 657-673. DOI 10.1007/s12520-016-0381-5.

Montana, G., Cau Ontiveros, M. A., Polito, A. M. and Azzaro, E. 2011: Characterisation of clayey raw materials for ceramic manufacture in ancient Sicily, *Applied Clay Science* 53, Amsterdam, 476-488.

Montana, G., Heinzel, C. E., Polito, A. M. and Randazzo, L. 2012: Archaeometric evidence attesting production of indigenous archaic pottery at Monte Polizo (Western Sicily), *Periodico di Mineralogia* 81(1), Roma, 107-130. DOI:10.2451/2012PM0007.

Montana, G., Polito, A. M., Corretti, A. and Serra, A. 2017: Compositional reference for the documented Archaic production of indigenous matt-painted pottery at Entella (Western Sicily), *Journal of Archaeological and Anthropological Sciences* 9, New York, 693-708.

Montana, G., Randazzo, L., Tsantini, E. and Fourmont, M. 2018b: Ceramic production at Selinunte (Sicily) during the 4th and 3rd century BCE: New archaeometric data through the analysis of kiln wastes, *Journal of Archaeological Science: Reports* 22, Amsterdam, 154-167. DOI: 10.1016/j.jasrep.2018.09.022.

Montana, G., Mommsen, H., Iliopoulos, I., Schwedt, A. and Denaro, M. 2003: The petrography and chemistry of thin-walled ware from a Hellenistic-Roman site at Segesta (Sicily), *Archaeometry* 45/3, Oxford, 375-389.

Montana, G., Polito, A. M., Kistler, E., Mohr, M. and Spatafora, F. 2021: The indigenous settlement of Monte Iato (western Sicily): an ethnoarchaeometric approach for outlining local Archaic ceramic productions, *Journal* of *Archaeological and Anthropological Sciences* 13, New York, 142. https://doi.org/10.1007/s12520-021-01380-7

Montana, G., Randazzo, L., Gasparo Morticelli, M., Baldoni, V. and Bechtold, B. 2022: The production of western Greek Amphorae in Agrigento (Southern Sicily): An archaeometric and archaeological characterisation of the late 6th-4th centuries BCE Series, *Journal of Archaeological Science: Reports* 45, Amsterdam. https://doi.org/10.1016/j.jasrep.2022.103627

Montana, G., Randazzo, L., Gasparo Morticelli, M., Bonfardeci, A. and Bechtold, B. forthcoming: Late 6th-early 4th century BCE western Greek amphorae produced in Selinunte (western Sicily): ceramic paste characterization by an integrated archaeometric approach, *Journal of Archaeological Science: Reports,* Amsterdam, forthcoming.

Nieto, X. and Santos, M. 2008: *El vaixell grec arcaic de Cala Sant Vicen*ç, Monografies del CASC 7, Museu d'Arqueologia de Catalunya, Girona.

Pratt, C. E. 2016: Greek commodities moving west: comparing Corinthian and Athenian amphorae in early Archaic Sicily, in:

Demesticha, S. and Knapp, A. B. (eds.), *Maritime Transport Containers in the Bronze-Iron Aegean and Eastern Mediterranean*, Uppsala, 195-213.

Sacchetti, F. 2012: *Les amphores grecques dans le Nord de l'Italie. Échanges commerciaux entre les Appennins et les Alpes aux époques archaïque et classique,* Bibliothèque d'Archéologie Méditerranéenne et Africaine 10, Aix-en-Provence.

Schreiber, B. C., Friedman, G. M., Decima, A. and Schreiber, E. 1976: Depositional environments of Upper Miocene (Messinian) evaporite deposits of the Sicilian Basin, *Sedimentology* 23(6), 729-760.

Serra, A. 2016: *La ceramica a decorazione geometrica dipinta da Segesta nel quadro delle produzioni della Sicilia occidentale*, BAR International Series 2779, Oxford.

Sourisseau, J.-Ch. 2006: Les amphores commerciales de la nécropole de Rifriscolaro à Camarine. Remarques préliminaires sur les productions Corinthiennes de type A, in: Pugliese Carratelli, G., Pelagatti, P., Di Stefano, G. and De Lachenal, L. (eds.), *Camarina: 2600 anni dopo la fondazione: nuovi studi sulla città e sul territorio* (Ragusa 2003), Roma, 129-147.

Sourisseau, J.-Ch. 2011: La diffusion des vins grecs d'Occident du VIII^e^ au IV^e^ s. av. J.-C., sources écrites et documents archéologiques, *La vigna di Dioniso: vite, vino e culti in Magna Grecia, Atti del quarantanovesimo Convegno di Studi sulla Magna Grecia* (Taranto 2009), Taranto, 145-252.

Spagnolo, G. 2002: Anfore da trasporto arcaiche e classiche nell'occidente greco: nuove acquisizioni da centri di rinvenimenti a Messina, in: Bacci, M. G. and Tigano, G. (eds.), *Da Zancle a Messina. Un percorso archeologico attraverso gli scavi,* vol. II, Messina, 31-46.

Spatafora, F. 2015: Santuari e luoghi sacri in un 'area di frontiera': la valle del Belice tra elimi, sicani, punici e greci, in: Kistler, E., Öhlinger, B., Mohr, M. and Hoernes, M. (eds.), *Sanctuaries and the Power of Consumption Networking and the Formation of Elites in the Archaic Western Mediterranean World, Proceedings of the International Conference (Innsbruck 2012),* PHILIPPIKA, Altertumswissenschaftliche Abhandlungen 92, Wiesbaden, 287-298.

Spatafora, F. 2018: Phoenicians, Greeks and "Indigenous peoples" in the Emporia of Sicily, in: Gailledrat, E., Dietler, M. and Plana-Mallart, R. (eds.), *The emporion in the ancient western Mediterranean. Trade and Colonial Encounters from the Archaic to the Hellenistic Period*, Montpellier, 181-190.

Vassallo, S. 2020: Guerre e conflitti nella Sicilia centro-settentrionale tra la metà del VI e la fine del V sec. a.C.: una prospettiva archeologica, in: Jonasch, M. (ed.), *The fight for Greek Sicily. Society, Politics, and Landscape*, Vancouver, 1-17.

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